

## CLAIMS

What is claimed is:

1. An electrical machine comprising:  
a stator including a plurality of stator teeth and one or more windings with compact coils disposed around the teeth, the one or more windings having (m) phases  
5 and (p) poles,  
where (m) is an integer and is greater than or equal to two,  
where (p) is an integer, is greater than or equal to two, and is an even number; and  
a rotor having a magnetization pattern including a magnetization skew of  
10  $(2\pi/(mp))$ .
2. The electrical machine of claim 1, wherein (t) is an integer and represents the number of stator teeth, wherein the stator teeth define a plurality of slots to receive the one or more windings, wherein each tooth includes a portion between two adjacent  
15 slots, the portion having a width ( $w_t$ ), and wherein the stator further includes a back iron having a radial width ( $w_y$ ) that satisfies the relationship  $(1.5 (t/(2p)) (w_t)) \leq (w_y) \leq (4.5 (t/(2p)) (w_t))$ .
- 20 3. The electrical machine of claim 2, wherein the one or more windings include an arrangement for the coils, and wherein the number of phases (m) and poles (p) has a relation to the arrangement.
4. The electrical machine of claim 1, wherein  $(m=2k+1)$  and  $(p=2j)$ , where (k)  
25 and (j) are integers greater than or equal to one, and wherein the free end of each stator tooth includes two channels along a surface adjacent to the rotor.
5. The electrical machine of claim 4, wherein each channel has a substantially trapezoidal shape.

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6. The electrical machine of claim 4, wherein each channel has a substantially curvilinear shape.

7. An electrical machine comprising:  
a shaft rotatable about an axis;  
a rotor coupled to the shaft and rotating with the shaft; and  
a stator including a plurality of stator teeth, each stator tooth including a  
5 channel along a surface adjacent to the rotor, each channel having a substantially  
trapezoidal shape.
8. The electrical machine of claim 7, wherein the trapezoidal shape of each  
channel includes an opening adjacent to the rotor, the opening having an opening  
width ( $w_b$ ), a base at a depth from the surface, the base having a base width ( $w_n$ ), and  
10 a pair of sides at a side angle ( $\alpha$ ) with respect to the base.
9. The electrical machine of claim 8, wherein the stator defines a plurality of slot  
openings between each stator tooth, each slot opening having a width ( $w_o$ ).
10. The electrical machine of claim 9, wherein the slot openings having a height  
opening ( $h_o$ ).
11. The electrical machine of claim 9, wherein ( $w_n$ ) satisfies the relationship  
15  $(0.5w_o) \leq (w_n) \leq (1.5w_o)$ .
12. The electrical machine of claim 9, wherein ( $w_b$ ) satisfies the relationship  
 $(0.3w_o) \leq (w_b) \leq (1.2w_o)$ .
13. The electrical machine of claim 9, wherein ( $\alpha$ ) satisfies the relationship  $(30^\circ)$   
20  $\leq (\alpha) \leq (135^\circ)$ .
14. The electrical machine of claim 9, wherein ( $w_n$ ) satisfies the relationship  
 $(0.5w_o) \leq (w_n) \leq (1.5w_o)$ , wherein ( $w_b$ ) satisfies the relationship  $(0.3w_o) \leq (w_b) \leq$   
 $(1.2w_o)$ , and wherein ( $\alpha$ ) satisfies the relationship  $(30^\circ) \leq (\alpha) \leq (135^\circ)$ .
15. The electrical machine of claim 9, wherein each stator tooth includes a second  
25 channel along a surface adjacent to the rotor, wherein each second channel includes a  
substantially trapezoidal shape.

16. The electrical machine of claim 15, wherein  $(w_n)$  satisfies the relationship  $(0.5w_o) \leq (w_n) \leq (1.5w_o)$ .

17. The electrical machine of claim 15, wherein  $(w_b)$  satisfies the relationship  $(0.3w_o) \leq (w_b) \leq (1.2w_o)$ .

5 18. The electrical machine of claim 15, wherein  $(\alpha)$  satisfies the relationship  $(30^\circ) \leq (\alpha) \leq (90^\circ)$ .

19. The electrical machine of claim 15, wherein  $(w_n)$  satisfies the relationship  $(0.5w_o) \leq (w_n) \leq (1.5w_o)$ , wherein  $(w_b)$  satisfies the relationship  $(0.3w_o) \leq (w_b) \leq (1.2w_o)$ , and wherein  $(\alpha)$  satisfies the relationship  $(30^\circ) \leq (\alpha) \leq (135^\circ)$ .

20. An electrical machine comprising:  
a shaft rotatable about an axis;  
a rotor coupled to the shaft and rotating with the shaft; and  
a stator including a plurality of stator teeth, each stator tooth including first  
5 and second channels along a surface adjacent to the rotor, each channel having a  
substantially trapezoidal shape.
21. The electrical machine of claim 20, wherein the trapezoidal shape of each  
channel includes an opening adjacent to the rotor, the opening having an opening  
width ( $w_b$ ), a base at a depth from the surface, the base having a base width ( $w_n$ ), a  
10 first side at a side angle ( $\alpha$ ) with respect to the base, and a second side at a side angle  
( $\gamma$ ) with respect to the base.
22. The electrical machine of claim 21, wherein the stator defines a plurality of  
slot openings between each stator tooth, each slot opening having a width ( $w_o$ ).
23. The electrical machine of claim 22, wherein ( $w_n$ ) satisfies the relationship  
15  $(0.5w_o) \leq (w_n) \leq (1.5w_o)$ .
24. The electrical machine of claim 23, wherein ( $w_b$ ) satisfies the relationship  
 $(0.3w_o) \leq (w_b) \leq (1.2w_o)$ .
25. The electrical machine of claim 23, wherein ( $\alpha$ ) satisfies the relationship  $(30^\circ) \leq (\alpha) \leq (90^\circ)$  and wherein ( $\gamma$ ) satisfies the relationship  $(30^\circ) \leq (\gamma) \leq (90^\circ)$ .
- 20 26. The electrical machine of claim 23, wherein ( $w_n$ ) satisfies the relationship  
 $(0.5w_o) \leq (w_n) \leq (1.5w_o)$ , wherein ( $w_b$ ) satisfies the relationship  $(0.3w_o) \leq (w_b) \leq$   
 $(1.2w_o)$ , and wherein ( $\alpha$ ) satisfies the relationship  $(30^\circ) \leq (\alpha) \leq (135^\circ)$ .

27. An electrical machine comprising:  
a shaft rotatable about an axis;  
a rotor coupled to the shaft and rotating with the shaft; and  
a stator including a plurality of stator teeth, each of the plurality of stator teeth  
5 having a free end adjacent to a rotor; and  
first and second channels located at the free end of each of the plurality of  
stator teeth, the first and second channels having a substantially curvilinear shape.
28. The electrical machine of claim 27, wherein each channel includes an opening  
having an opening width ( $w_o$ ).
- 10 29. The electrical machine of claim 28, wherein the stator defines a plurality of  
slot openings between each stator tooth, each slot opening having a width ( $w_o$ ).
30. The electrical machine of claim 28, wherein each curvilinear shape has a  
centerline, and wherein each curvilinear shape follows an arc of a circle with a center  
on the centerline.
- 15 31. The electrical machine of claim 30, wherein the circle has a diameter ( $d$ ) that  
satisfies the relationship  $((0.75w_o) \leq (d) \leq (1.5w_o))$ .